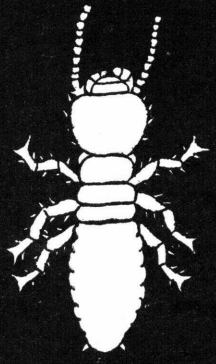
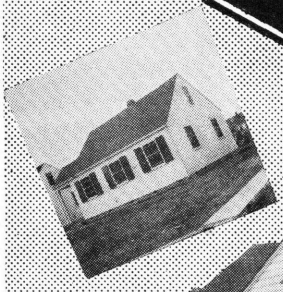
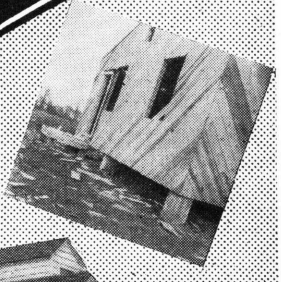
PREVENTING DAMAGE TO BUILDINGS BY SUBTERRANEAN TERMITES AND THEIR CONTROL



FARMERS' BULLETIN
No. 1911





U.S. DEPARTMENT OF AGRICULTURE

MAINTENANCE COSTS associated with wooden buildings, or masonry buildings in which wood is used for floors, partitions, and other parts of the structures, are often greatly increased because of damage caused by termites, sometimes called "white ants." Wood is still the most adaptable of all construction materials and should not be discriminated against because of the possibility of its being damaged by termites. It is not difficult to construct wooden buildings that are fully protected against such damage if careful consideration is given to the problem during the planning of buildings as well as during the process of actual construction.

After buildings have once become infested by termites, it is often rather difficult, as well as costly, to apply control measures effectively. Prevention of infestation, by using practices recommended in this bulletin in all new construction, is therefore highly desirable. If infestation does occur, the most effective and permanent control measures will require the making of structural alterations that will correct faults in the original construction. Chemicals applied as soil poisons are often useful as a supplementary control measure.

The manuscript of this bulletin was prepared before some of the metals and chemicals mentioned were required for the war effort. Protection of buildings from termites, however, is more a matter of correct building practices than of use of special materials; and when chemical treatments are recommended, there is usually a choice of chemicals, so that shortage of one or more of them need not prevent proper precautions being taken in the construction and care of buildings.

This bulletin supersedes Farmers' Bulletin No. 1472, Preventing Damage by Termites or White Ants, and Leaflet No. 101, Injury to Buildings by Termites.

Washington, D. C. Issued November 1942

PREVENTING DAMAGE TO BUILDINGS BY SUBTERRANEAN TERMITES AND THEIR CONTROL

Prepared in the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine

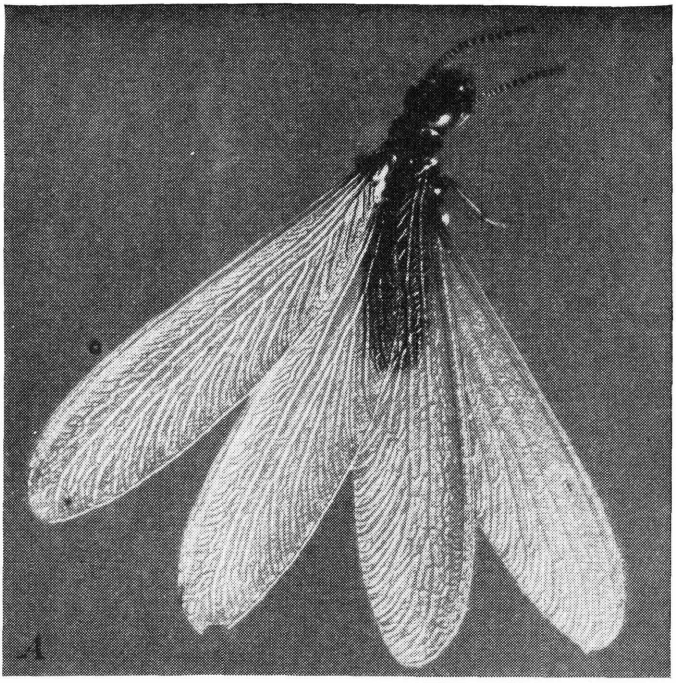
Contents

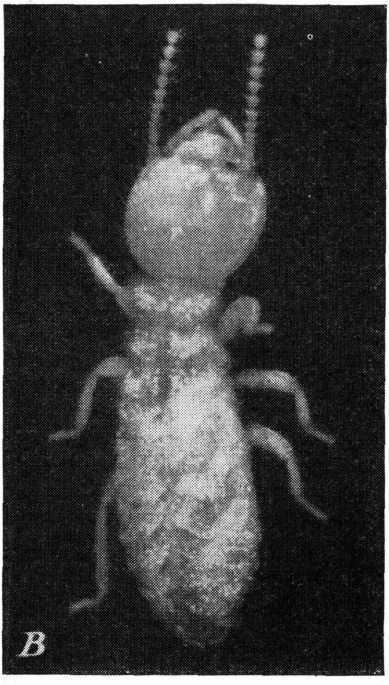
SUBTERRANEAN, or ground-nesting, termites [1] cost the people of the United States many millions of dollars each year. No adequate survey to determine the actual amount of damage has ever been made, but it is known that large sums of money are spent in making repairs and in applying control measures.

Termite control will be a major item in the maintenance of many of the military and defense housing projects. Because of the need for speed in construction and the impossibility of providing thorough supervision, certain of the important preventive measures have been disregarded, especially in many of the earlier projects. A large number of private and Federal housing projects for workers in war industries and at military centers are still to be constructed. It is hoped that the information given in this bulletin will be of assistance in drawing up plans that will result in a minimum of future damage by termites. Effective preventive measures used in all new construction and the application of effective control measures where termite infestations do develop will contribute to the success of the war program by reducing waste of materials and manpower.

The United States Department of Agriculture receives many thousands of requests each year for information on termites. This tremendous amount of public interest is occasioned by what is often an unwarranted fear of immediate and critical damage to buildings. Many greatly exaggerated statements have been made regarding the destructiveness of termites, and people have come to regard termite

[1] Genera *Reticulitermes* Holmgren, *Heterotermes* Froggatt, and *Amitermes* Silvestri. Nonsubterranean termites will be discussed in a separate publication.





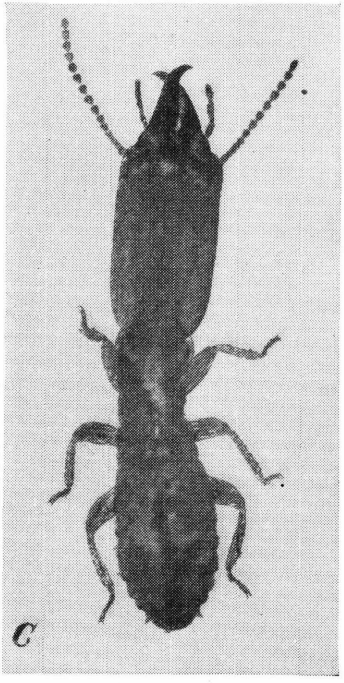


FIGURE 1.—Winged sexual adult, or reproductive (*A*), adult worker (*B*), and adult soldier (*C*) of the eastern subterranean termite, *Reticulitermes flavipes* Kollar. *A* 8 times, *B* 14 times, and *C* 12 times natural size.

infestation in a building as being something requiring immediate, drastic, and expensive repairs or treatment to avoid ultimate destruction of the building.

The hazard of termite infestation is, however, sufficiently great in most parts of the United States to warrant the use of protective measures in all new construction where wood is used. An increasingly large proportion of the lumber now being placed on the market is from young, second-growth trees containing a large amount of sapwood, and is therefore very attractive to termites. This fact, together with certain changes in architectural design, is almost certain to result in termite infestation becoming more general and more destructive, except where adequate precautions are taken. It is highly important that preventive measures be included in the design and actual construction of all new buildings in areas where termites are known to be a problem. Fortunately, it is possible to prevent infestation by using measures that are easily applied and that are not expensive. Such measures will be discussed in detail in a later section of this bulletin. When these measures are applied they pay good dividends in terms of lower maintenance costs.

If a building is found to be infested by termites, a detailed and careful examination should be made to determine the extent of the infestation and the control measures that will be needed to prevent further damage. Many cases will require only fairly simple structural changes, repairs, or chemical treatments which can be made by or under the supervision of the owner. Others will necessitate the services of an operator who has a thorough knowledge of the habits of termites and is adequately trained and experienced in termite-control work.

HOW TO RECOGNIZE SUBTERRANEAN TERMITES

Subterranean termites are social insects that live in nests, or colonies, in the ground. Each colony is made up of three forms, or castes—reproductives, workers, and soldiers (fig. 1). The individuals of each of these three castes pass through three stages during their life history—egg, nymph, and adult. The adult workers and soldiers are wingless, and are grayish white in color and similar in appearance, except that the soldiers have much larger heads and longer mandibles, or jaws. Both of these forms lead a concealed life within their tunnels in wood and soil. The reproductives, or sexual adults, have brown or black bodies and are provided with two pairs of long, whitish, opaque wings of equal size. In contrast, the reproductive forms among the true ants (fig. 2) have two pairs of wings which are of unequal size and are transparent. Termites may be easily distinguished from true ants by the fact that termites do not have the strongly constricted waistline that is characteristic of all ants.

DISTRIBUTION OF TERMITES

Termites are known to occur practically throughout the tropical and temperate parts of the world. The subterranean species are common throughout most of the eastern half of the United States and along the Pacific coast, but are abundant from Massachusetts south along the Atlantic coast and the Gulf of Mexico, in the Ohio River Valley, in the southern part of the Missouri and Mississippi River Valleys, and in southern California.

Figure 3 shows the approximate relative hazard of infestation by termites, as based upon experience and reports of damage received by

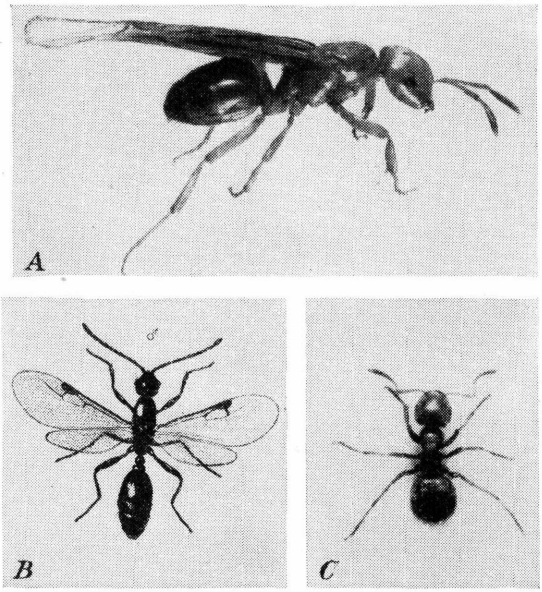


FIGURE 2.—Winged sexual adults (*A* and *B*) and worker adult (*C*) of common ants.

the Bureau of Entomology and Plant Quarantine. The hazard varies greatly within a general area, and for any specific locality it will

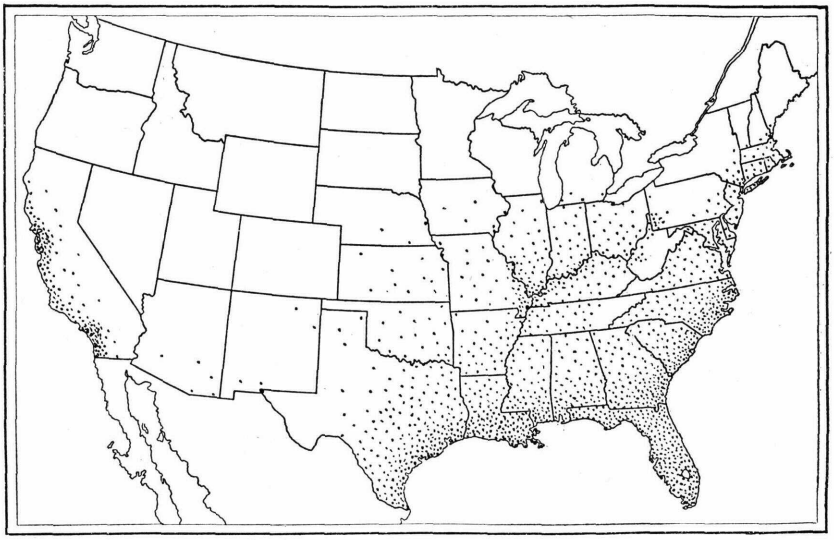


FIGURE 3.—Map showing, by density of stippling, the relative hazard of infestation by subterranean termites. These termites occur in every State.

depend upon such factors as type of soil, moisture conditions, and local building practices.

Termites are native insects and have occurred in very nearly their present distribution for many millions of years. There is no evidence of any introduction or spread of subterranean termites from the Tropics to the United States, or of movement of any of our native species from the Southern to the Northern States. Infestations in buildings have, however, become more common following the general adoption of central heating plants. Heated basements are favorable for a longer period of termite activity, and this fact, together with other

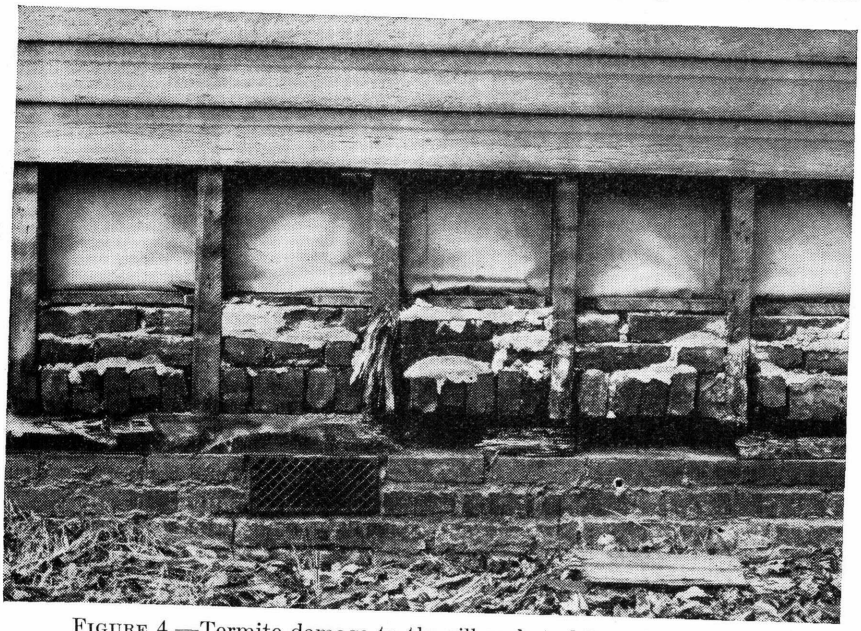


FIGURE 4.—Termite damage to the sill and studding of a building.

changes in building practices and use of construction materials, has resulted in termites becoming a problem in areas where formerly they were not of importance.

TYPES OF MATERIALS DAMAGED BY TERMITES

The principal food of termites is cellulose, obtained from wood and other plant tissues. Termites are destructive to the woodwork of buildings (fig. 4), telephone poles, fence posts, or any other wood in contact with the ground. Paper (fig. 5), fiber board, and various types of fabrics derived from cotton and other plants are often damaged. Termites will occasionally injure living trees, shrubs, nursery stock, grapevines, and even certain herbaceous plants, but by far the greatest economic loss is caused by their activities in the woodwork of buildings.

DEVELOPMENT OF A TERMITE COLONY

Emergence or colonizing flights of termites most frequently occur after the first warm days of spring, often following a warm rain, but may take place at almost any time during the spring or summer. In buildings with heated basements, flights will occasionally occur even

during the winter. The individuals in these flights are young winged reproductives, or so-called kings and queens, that have developed in well-established colonies. They are attracted by strong light at this

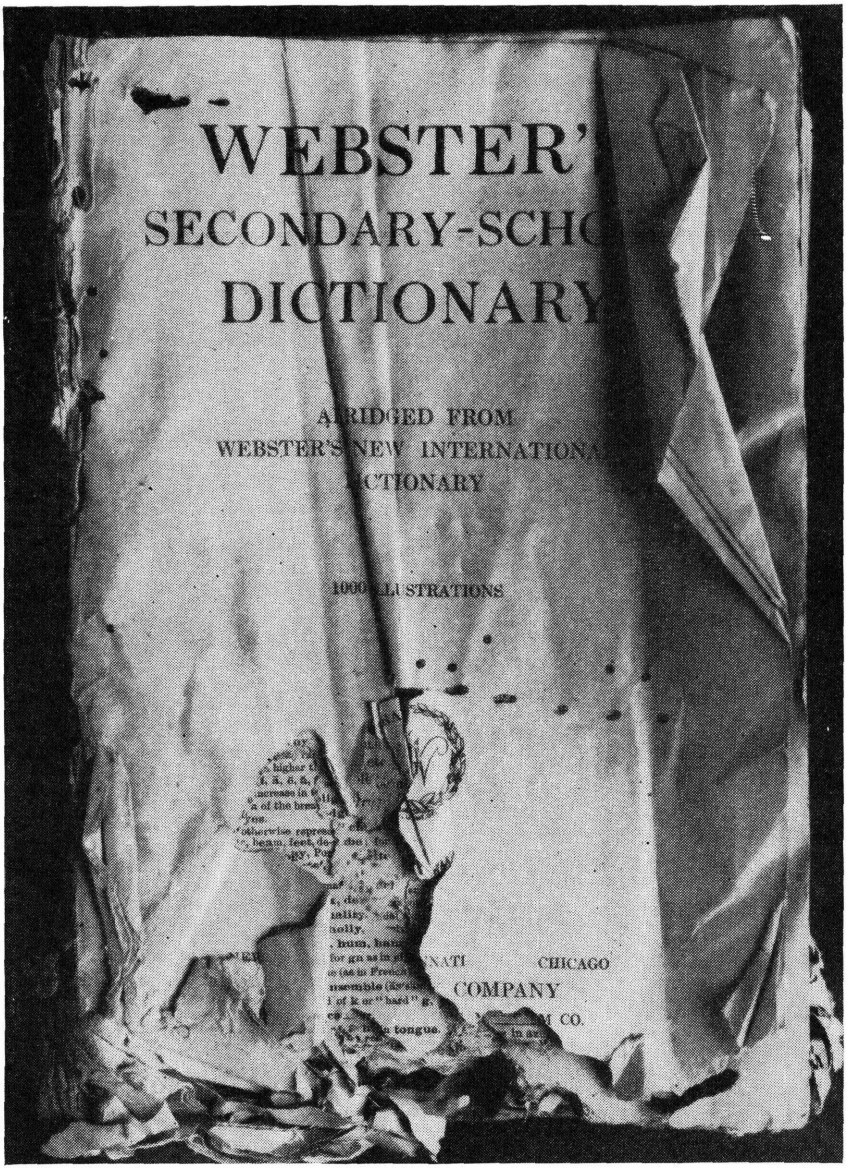


FIGURE 5.—Book damaged by termites. Paper and other cellulose products stored in an infested building may be damaged by these insects.

time, and when they emerge within buildings they will gather about windows or doors in an endeavor to get outside. They soon shed their wings, and then each pair attempts to return to the soil to find a suitable location for starting a new colony.

Most of these adults perish, but a few pairs may survive and succeed in hollowing out small cells in or near wood in the ground. The female, or queen, of each pair produces only a few eggs the first year. The young are cared for by the parent adults and develop into workers

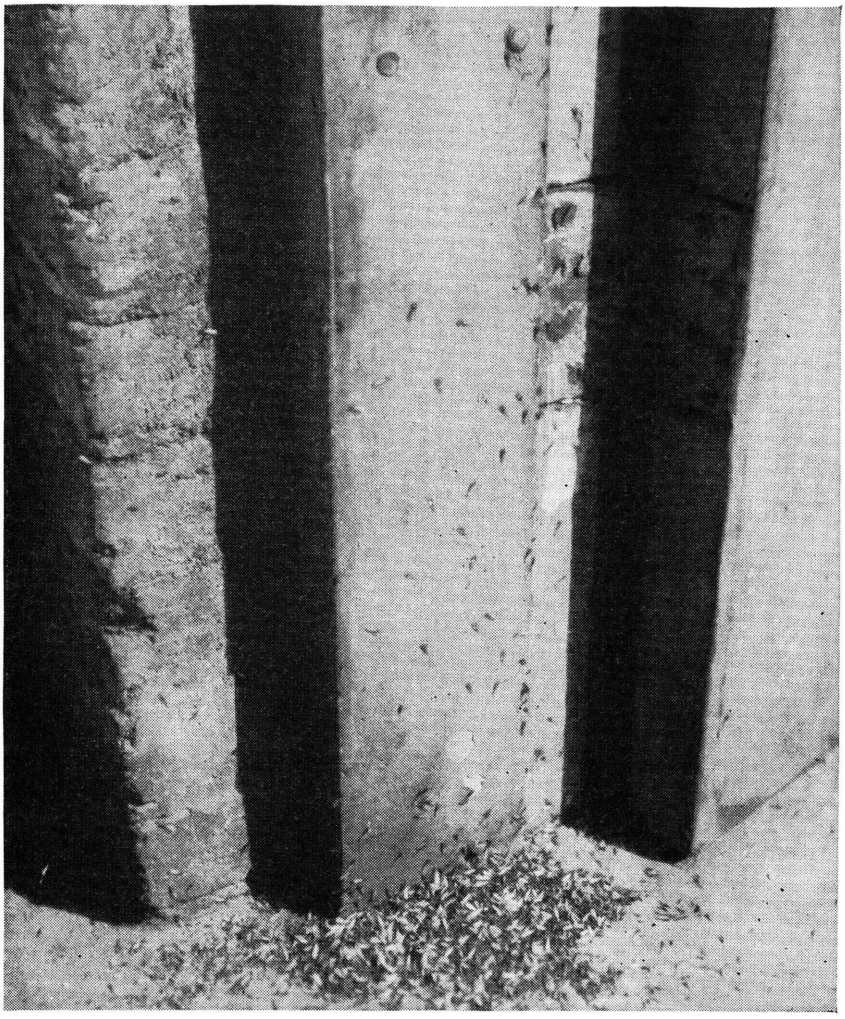


FIGURE 6.—Swarm of reproductive termite adults.

and soldiers that gradually take over many of the duties formerly performed by the original royal pair.

The rate of reproduction increases rather rapidly after the first 2 or 3 years. Secondary reproductive forms, without wings, also produce eggs and serve to supplement the original queen. A colony that is more than 5 or 6 years old may thus contain several thousand individuals, the vast majority of which are workers. Although a colony may increase in size comparatively rapidly, it is evident that very little

damage to a building is likely to be caused by a colony that is less than 8 or 10 years old. Where serious damage occurs in a shorter period of time, it is usually because a large population of termites was present in the soil before the building was constructed.

HOW TO RECOGNIZE THE PRESENCE AND WORK OF TERMITES

Large numbers of winged reproductive termites emerging, or "swarming," from the soil or wood may be the first indication of the presence of a termite colony (fig. 6). Even though the actual flight of these adults is not observed, the presence of their discarded wings (fig. 7) is a positive indication of a well-established colony nearby.

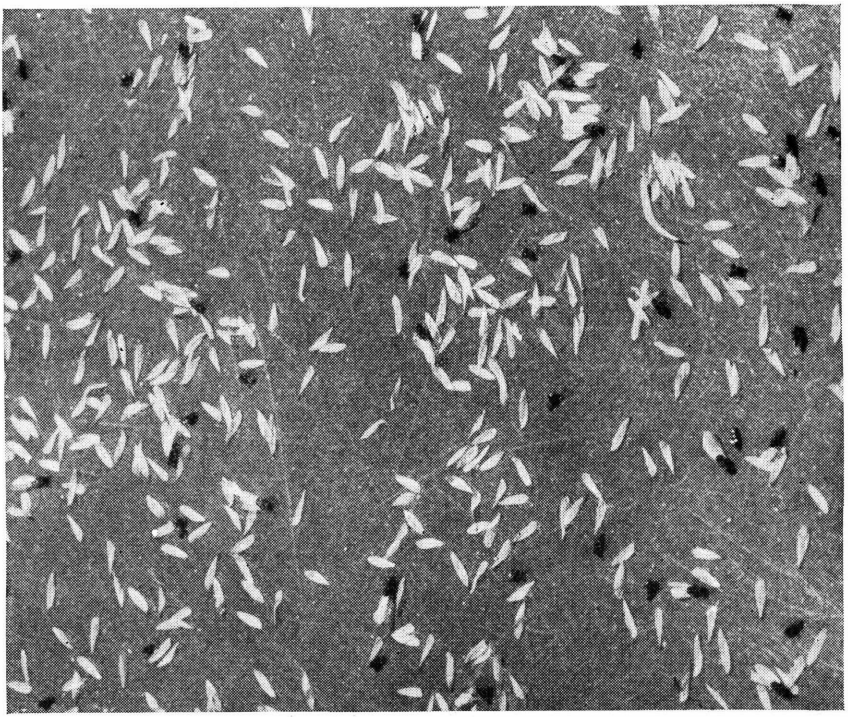


FIGURE 7.—Winged adult termites and discarded wings—proof of the presence of a colony nearby.

These discarded wings are often found on the floor beneath doors or windows where termites have emerged within a building and have been unable to escape.

Termite damage to wood is often not evident from the exterior (fig. 8, *A*). The workers avoid free exposure to the air and therefore construct their galleries within the materials which they attack. Occasionally they completely honeycomb wooden timbers, leaving little more than a thin shell (fig. 9). The inside of their galleries is covered with grayish specks of excrement and earth (fig. 10). Subterranean termites do not reduce the wood to a powdery mass or push wood particles to the outside through openings, as do certain other types of wood-boring insects.

Termite infestation may also be evidenced by the presence of earth-like shelter tubes, which these insects may construct over the surfaces of foundation walls (fig. 11) or other materials to afford additional runways between the soil and their source of food. These tubes vary in size and shape, being from one-fourth to one-half inch or more in width and flattened against the supporting surface. They serve as covered passageways between the wood and the essential moisture in

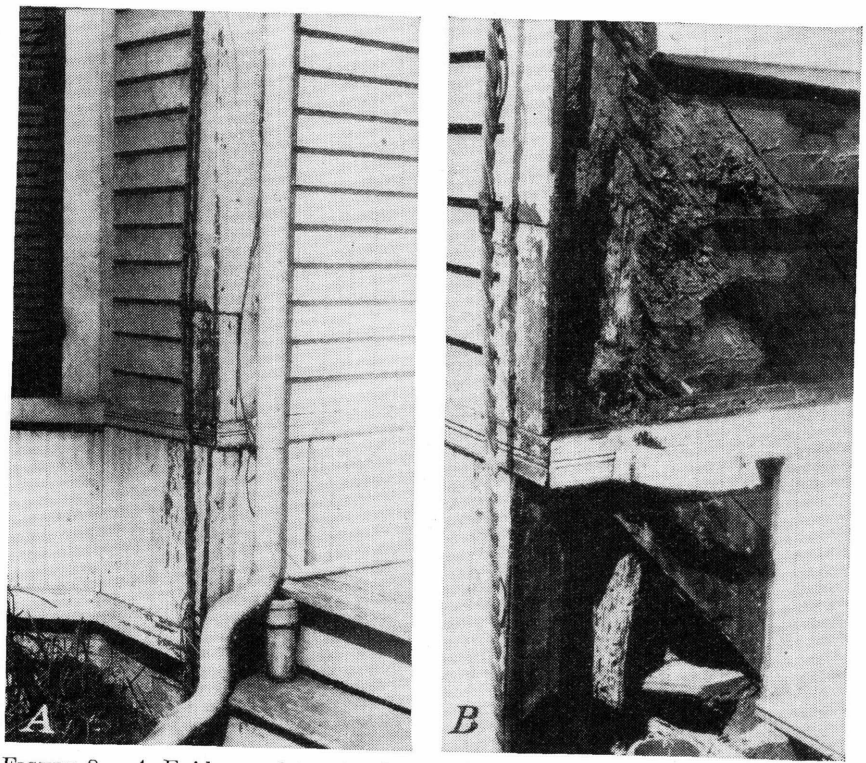


FIGURE 8.—*A*, Evidence of termite damage from the outside of a building, which is usually inconspicuous; *B*, siding removed from the same building to reveal extent of damage to the sill, studding, and subsiding.

the soil and protect the termites from the drying effect of direct exposure to the air (fig. 12).

CONDITIONS THAT FAVOR TERMITE INFESTATION IN BUILDINGS

Subterranean termites become most numerous in moist, warm soil containing an abundant supply of food in the form of wood or other lcelulose material. Such conditions are often found beneath buildings where the space below the first floor is poorly ventilated and where scraps of lumber, form boards, grade stakes, or tree stumps are left in the soil (fig. 13). Most termite infestations in buildings occur because of wood being in direct or indirect contact with the ground, particularly at porches, steps, or terraces. Cracks or voids in foundations and concrete floors also make it easy for termites to reach wood that is not in actual contact with the soil. Soil within or adjacent to heated basements is kept warm throughout most of the year, even in northern areas, prolonging the normal period of termite activity.

PREVENTION OF INFESTATION BY TERMITES

Experience has shown that certain practices common in the design and construction of buildings are conducive to infestation by termites. In perhaps the majority of cases these practices result from ignorance of, or indifference to, the danger of termite infestation. The suggestions [2] that follow are made with the object of encouraging the use of design and construction practices that will give effective protection against infestation as well as embody principles that are good from the

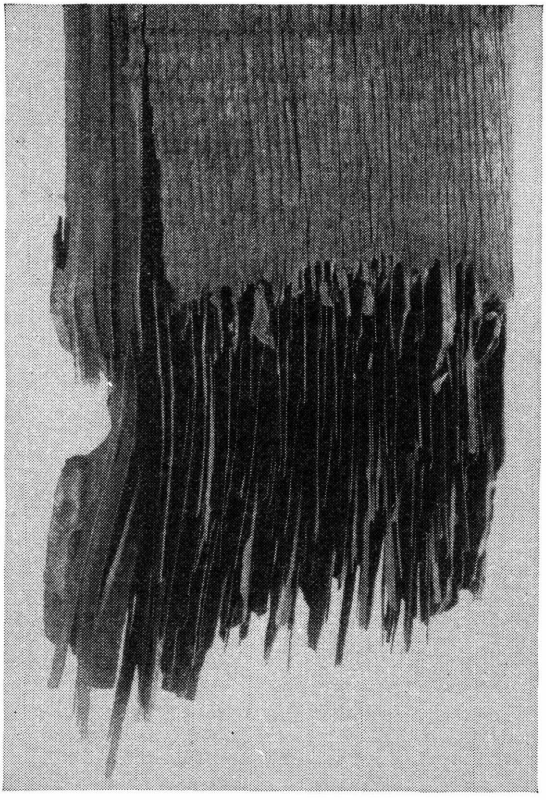


FIGURE 9.—Wood honeycombed by termites. A portion of the exterior surface has been removed to reveal the extensive tunneling within, along the grain.

standpoint of the architect and builder. **Too much emphasis cannot be placed upon the fact that the best time to provide protection against termites is during the planning and construction of a building.**

Effective protection against infestation by termites can be assured by careful observance of the following practices in the construction and maintenance of all buildings in which wood is used:

1. Remove all stumps, wood debris, and other cellulose material from the building site before construction is begun. If termites are found to be present in the soil, apply chemicals to kill them.
2. Remove all form boards and grade stakes.

[2] Most of these suggestions apply equally well to the prevention of decay.

3. Do not allow scraps of lumber and other wood debris to become buried in the backfill adjacent to the foundation or in fill material used under porches, terraces, or steps.
4. Place the building on a foundation that is impervious to termites.
5. Avoid all contacts between woodwork of the building and soil or fill.
6. Provide sufficient clearance beneath all parts of a building to give crawl space for making future inspections.
7. Provide ventilation openings in the foundation, arranged to prevent dead-air pockets and of sufficient size to assure frequent changes of air.
8. Provide for thorough drainage of the soil beneath the building.
9. Make thorough annual inspections for evidence of termite activity, such as shelter tubes on foundation surfaces.

These broad generalizations are elaborated and defined in the pages that follow.

WOOD IN THE SOIL

All tree roots, stumps, or other wood debris should be removed from the building site before construction work is started. If termites are

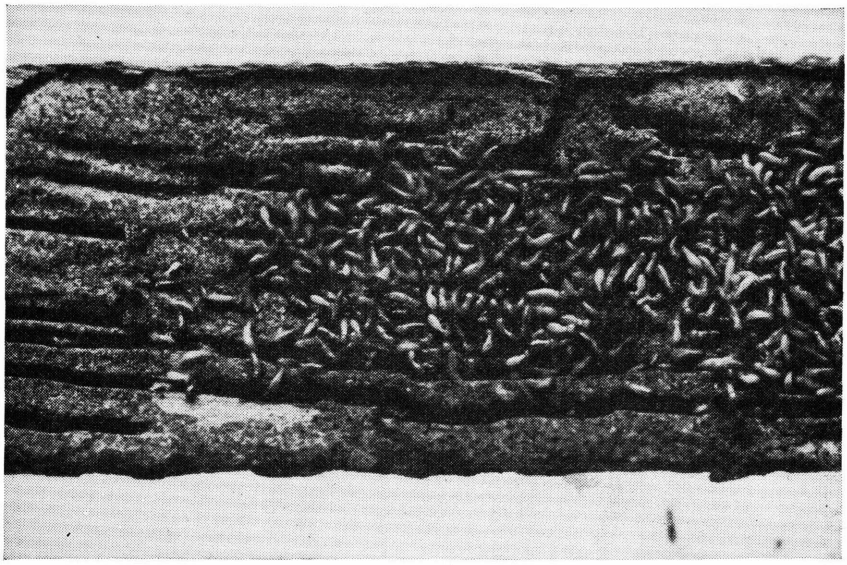


FIGURE 10.—Surface of wood removed to show termites at work. Note the grayish specks of excrement on the walls of the galleries.

found in such debris or in the soil, it is advisable to destroy them by the use of chemicals, as described on pages 34–37, especially if the soil is not to be excavated. Form boards, stakes used to hold forms in place, and all scraps of lumber should be removed before filling or backfilling after the foundation is completed. It is particularly important to avoid burying wood beneath porches, terraces, and steps. Spreader sticks and grade stakes should be pulled before the concrete sets. In the case of buildings without basements, scraps of lumber should not be allowed to remain on the surface of the soil beneath the buildings. **If no wood is left in or on the soil, the danger of a large population of termites developing in the soil and later attempting to infest the building is practically eliminated.**

TYPES OF FOUNDATIONS

All foundations should be made impervious to termites so as to prevent hidden attack of woodwork above. Cost limitations and other

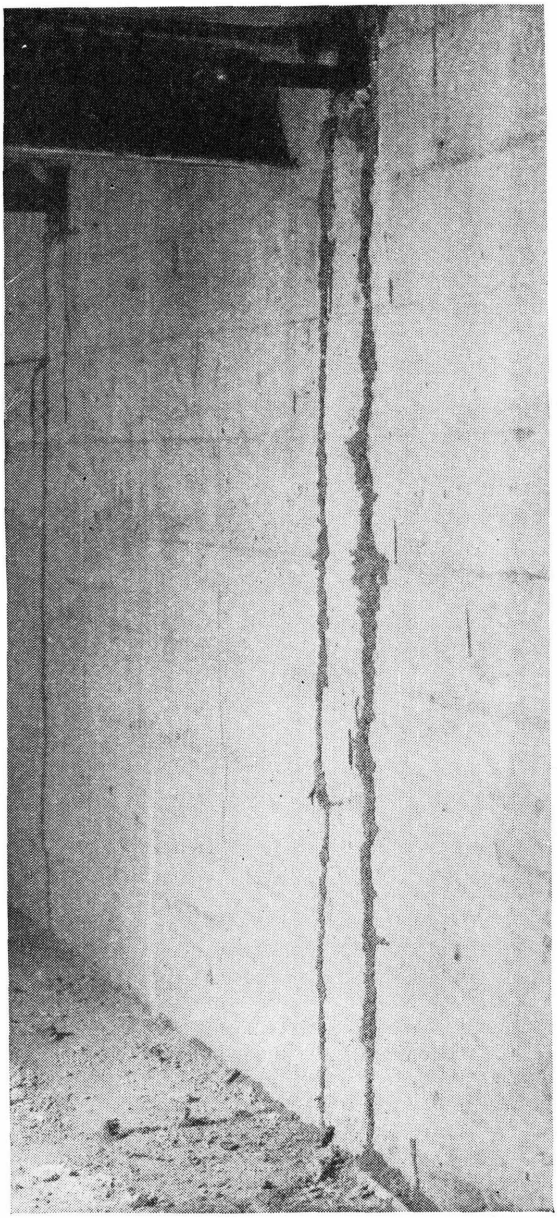


FIGURE 11.—Termite shelter tubes extending down over poured concrete wall, connecting wood and ground. Form boards left in place around openings for pipes attracted termites from the soil outside the foundation.

considerations will sometimes make it impossible fully to achieve this objective, but it is one of the most important protective measures and

should be considered very carefully in all new construction. Foundations may be rated as to their relative resistance to penetration by termites as follows:

1. Poured concrete (fig. 14) properly reinforced to prevent large shrinkage or settlement cracks will give the greatest protection. Cracks that are 1/32 inch or more in width will permit the passage of termites and should be prevented insofar as possible.
2. Masonry walls or piers capped with a minimum of 4 inches of reinforced poured concrete (fig. 15) or its equivalent will also be effective.

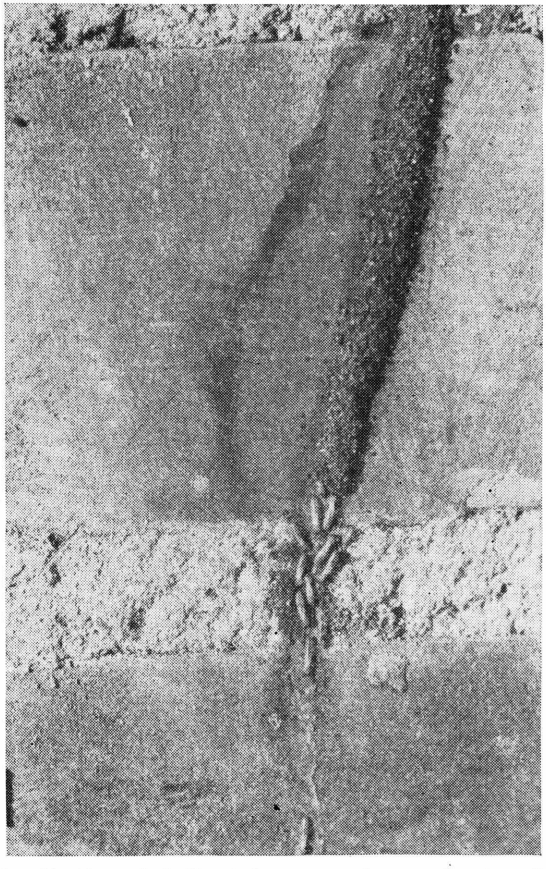


FIGURE 12.—Portion of shelter tube removed, exposing termites within.

3. Masonry walls or piers capped with precast solid-concrete blocks or brick, with all joints completely filled with cement mortar or poured lean grout, are often satisfactory but must be very carefully constructed.
4. Hollow-block foundations with the cells of the top course of blocks and with all joints between blocks completely filled with concrete may be satisfactory for low-cost construction.
5. Hollow-block or tile foundations with the cells of the top course of blocks left open give little or no protection.

Capping of the types described in paragraphs 3 and 4 above should be used only where constant, rigid supervision can be given to the work. Shrinkage or settlement cracks are almost certain to form in the cells or the vertical joints between blocks or bricks and thus allow infestation

which cannot be seen on inspection. A further objection is the fact that poor workmanship cannot be detected after the floor framing is in place.

Where the use of wooden piers or posts for foundations is unavoidable, as is sometimes true in the construction of cheap, temporary buildings, wood that has been impregnated with an approved chemical preservative by a standard pressure process, or heartwood of naturally resistant species, should be required (see page 26). As an additional safeguard, metal termite shields (see page 27) may be installed on top of such piers or posts so as to prevent termites from tubing up through

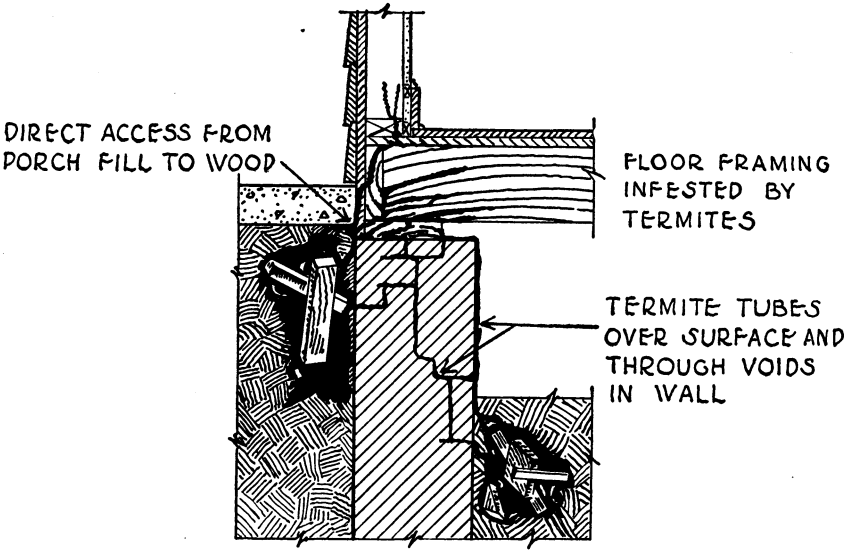


FIGURE 13.—Diagram showing how wood debris in the soil, even in very small quantities, enables termites to develop colonies that may later infest the building. An infestation originating in such debris may spread through hidden points of access from the porch fill or up through voids or cracks in a unit-type wall. Concentration of termite colonies under such conditions may stimulate the construction of shelter tubes over the surface of a wall in enclosed or partially excavated areas.

season checks or cracks in the posts or piers and gaining hidden access to the building.

CLEARANCE BENEATH BUILDINGS

A minimum clearance of 18 inches should be required beneath all wood substructures, to provide crawl space for making periodic inspections (fig. 15). In the southern and more humid sections of the country a minimum of 24 or preferably 30 inches is desirable. Clearance of less than 18 inches will not give room for making inspections for termite activity or for applying control measures in case infestations are found.

The outside grade line should be kept at least 6 inches below all exterior woodwork, so that the outer surface of the foundation may be inspected. If the superstructure is of brick or other types of masonry, the grade line should be at least 6 inches below the top of the

foundation. If a masonry foundation is capped with solid concrete blocks, the grade line should be kept at least 4 inches below the uppermost horizontal joint so as to prevent direct entry by termites from the soil to cracks in the vertical joints between blocks.

VENTILATION BENEATH BUILDINGS

Ventilation openings (fig. 16) in foundation walls beneath buildings without full basements should be of sufficient size and so distributed as to assure frequent changes of air and prevent dead-air spaces. Openings placed near the corners of buildings will usually result in the best cross ventilation. The openings need not be placed in the foundation on the front side of a building, provided they can be otherwise arranged to prevent any "dead ends" or unventilated areas. The size and number of openings needed will vary greatly with local conditions of soil moisture, atmospheric humidity, and air movement. Shrubbery should be kept away from the openings a sufficient distance to allow free circulation of air and to allow inspection of wall surfaces for the presence of termite tubes.

As a general rule for average conditions, ventilation openings having a net area of one-half square foot per 25 linear feet of exterior foundation wall plus one-half of 1 percent of the area enclosed by the foundation will prove satisfactory.

On very dry, exposed sites a smaller amount may be sufficient, and on wet sites it may be necessary to double or even triple the normal amount.

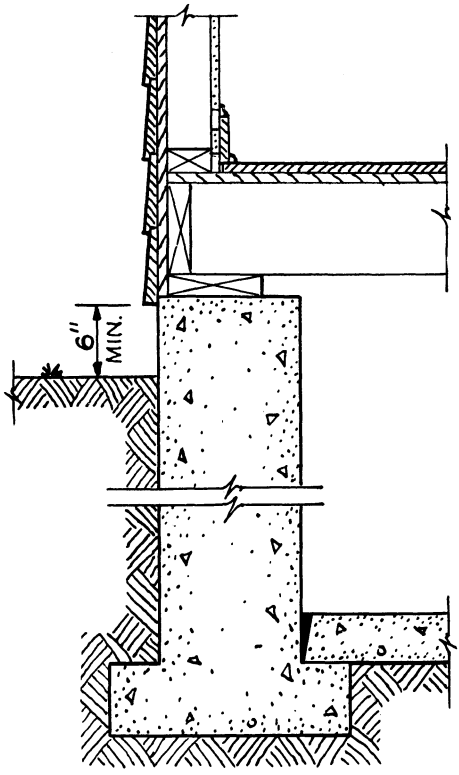


FIGURE 14.—Poured-concrete foundation walls or piers that are easily inspected, offering complete protection against hidden termite infestation. All form boards and wood debris must be removed from the soil. Expansion joints should be filled with coal-tar pitch.

DRAINAGE BENEATH BUILDINGS

As stated before, moisture is absolutely essential to termite activity. Every possible effort should be made to prevent moisture from accumulating in the soil beneath a building. The soil surface should be sloped so that surface water will drain away from the building rather than be allowed to collect beneath it or adjacent to the foundation. Eaves and downspouts connected to a storm sewer system are very helpful. Buildings with basements should have drainage tile around the outside of the foundation footings if the site is low or wet.

PORCHES AND TERRACES OF CONCRETE OR MASONRY

It is highly important that concrete or masonry porches, terraces, and steps be effectively isolated from the building proper. The floor or slab of such an entrance platform nearly always joins the exterior wall of the building at a point above the top of the foundation. This condition provides termites with hidden access from the soil to the woodwork of the building and is responsible for a large proportion of all termite infestations in buildings (fig. 17).

Protection against such infestation can be provided by the use of a properly designed and installed metal barrier or apron (figs. 18 and 19). This apron must effectively isolate the soil and slab from the woodwork of the building and make an impervious barrier to termites. An important feature that should be embodied in all such aprons is a ver-

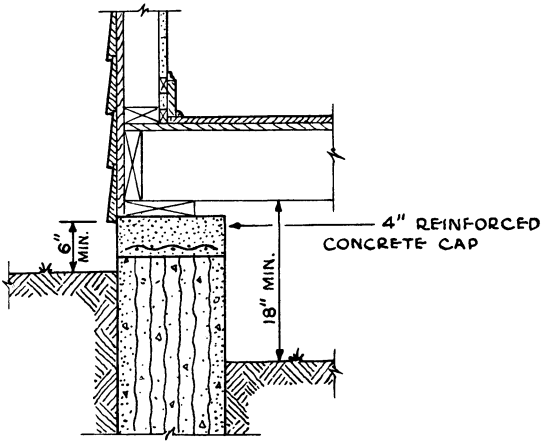


FIGURE 15.—A reinforced poured-concrete cap on masonry walls or piers, preventing hidden attack by termites. This cap should be at least 4 inches thick and must be poured in one continuous operation so as to avoid joints. Minimum clearance of 18 inches under the building and 6 inches outside will allow inspection for the presence of termite tubes or for possible cracking of the cap.

tical extension to serve as a flashing to prevent moisture from reaching the sill and causing decay.

The filling of porches, terraces, and steps should be discouraged and avoided wherever possible. Cinder fill is especially objectionable because, even if a copper apron is installed, there is almost certain to be rapid corrosion of the metal by the action of chemicals, particularly sulfur, contained in the cinders. Painting the apron with asphalt after the apron is in place will help to prolong the life of the metal. Where such structures are not filled, the slab or floor should be adequately reinforced, and an access door should be left in the foundation so that the form boards can be removed and periodic inspections can be made. Ventilation openings must also be provided. The use of a metal apron as described above is advisable even with these precautions, because of the danger of termites finding hidden access through the joints between the side walls of the porch and the main foundation.

EXTERIOR WOODWORK

Wooden Porches or Steps

The lower or outer step and the platform supports should rest upon poured- or solid-concrete bases or aprons extending at least 6 inches above grade (fig. 20). If the sides of porches are to be enclosed, the

FIGURE 16.—A ventilator in a foundation wall. Ample ventilation beneath the floor of a building is essential in preventing damage by termites and decay. See cover illustration.

siding or latticework should have at least 2 inches clearance above the ground. Provision should be made for adequate ventilation and access through the side walls for inspection. It is often practical to separate the entire structure from the building by a space of 2 to 4 inches.

Door Frames

Door frames or jambs should not extend into or through concrete floors that rest on soil (fig. 21). This is particularly true for garage doors or doors leading into basements from outside stairways.

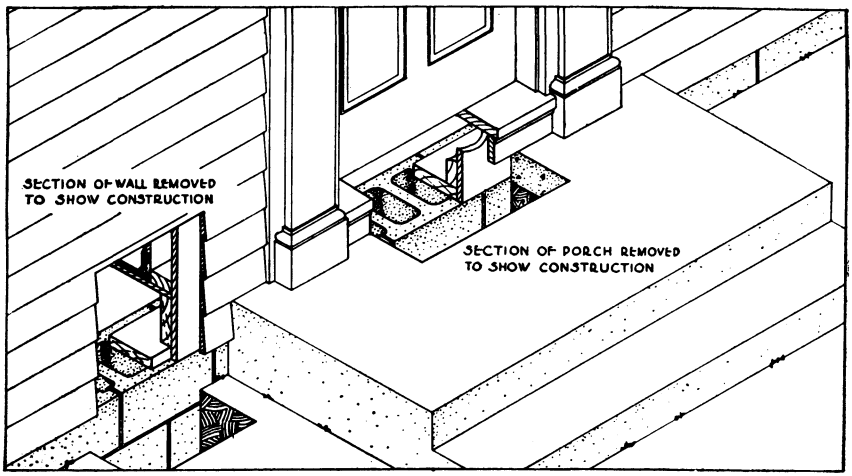


FIGURE 17.—Construction without special protection at porches, steps, and terraces. The absence of special protection is responsible for the great majority of termite infestations. Termites may gain access to the woodwork of a building directly from the fill material or soil beneath such entrance platforms and through voids and settlement or shrinkage cracks in a masonry wall. (See figure 18 for preventive measures.)

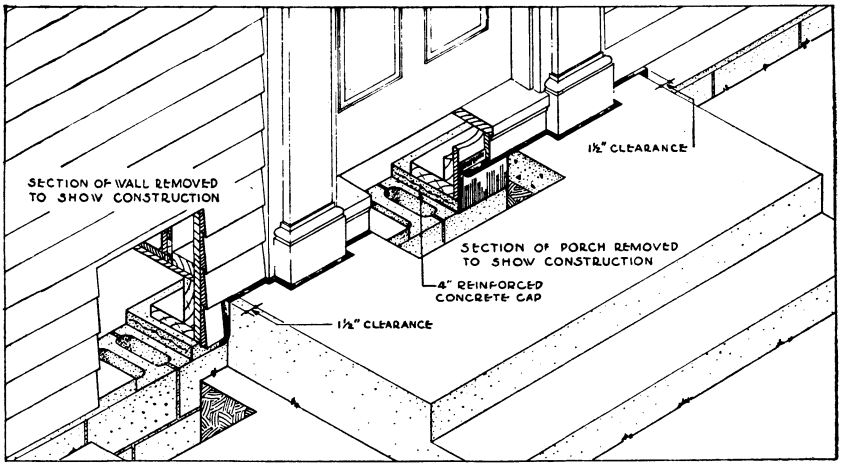


FIGURE 18.—Special protection at porches, steps, and terraces against hidden attack by the use of a metal apron to isolate the entrance platform and soil or fill from the building. Note the projection of the apron at the top and ends of the porch slab. This is essential. (See figure 19 for further details.) The reinforced poured-concrete cap on the masonry foundation wall prevents hidden access through the wall back of the apron or beyond the porch.

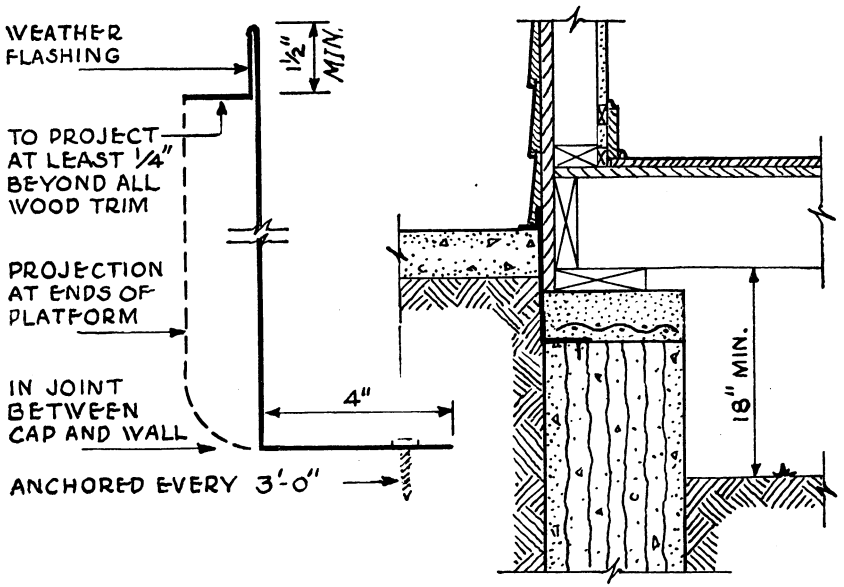


FIGURE 19.—Metal apron inserted between concrete slab and woodwork, anchored to unit-type foundation, and capped with reinforced concrete. The apron serves as a weather flashing as well as a termite barrier.

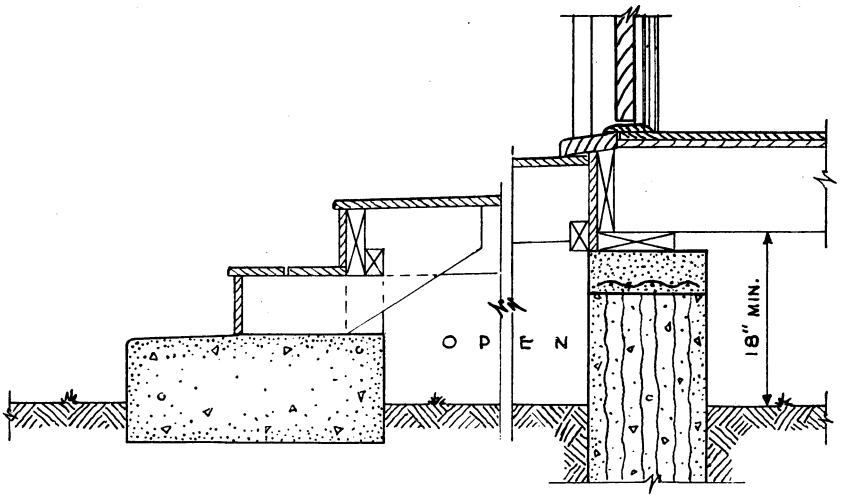


FIGURE 20.—Wooden steps or porch protected from hidden infestation by resting carriage on a poured-concrete base which forms the lower step. Platform attached to building above the poured-concrete cap on foundation wall or pier.

Windows Below Grade

When windows or other openings near or below outside grade are framed with wood, the foundation wall surrounding the wood frame must be impervious to termites, and the level of the areaway or well

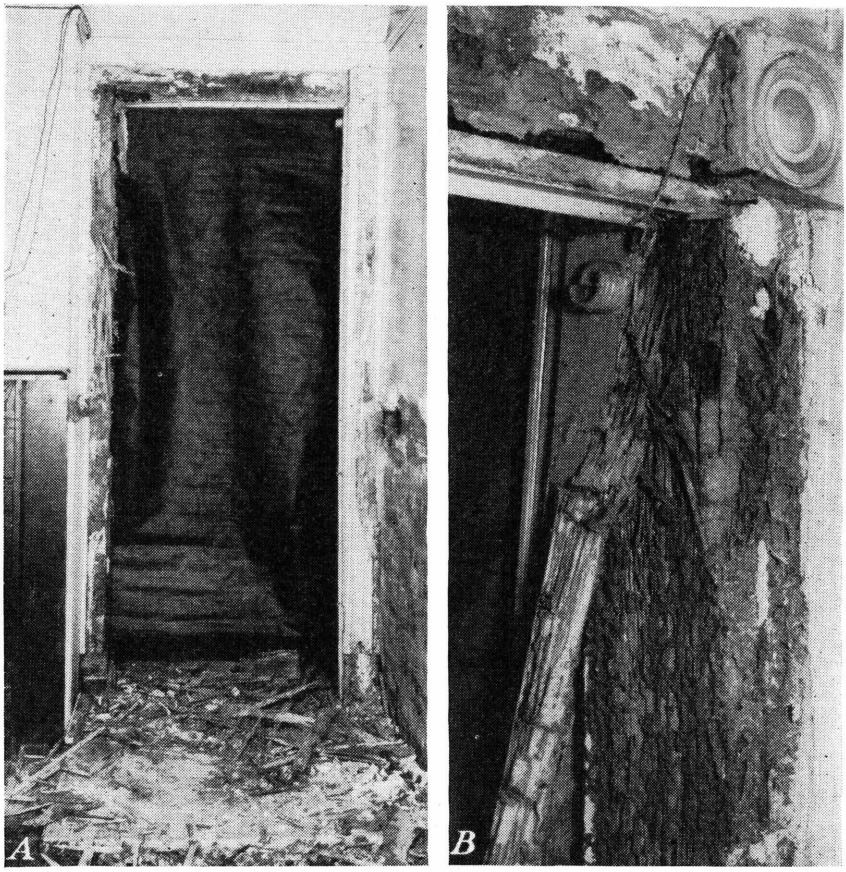


FIGURE 21.—*A*, Damaged floor, paneling, and doorframe in basement apartment, as a result of improper insulation of wood from the ground; *B*, part of the door frame shown in *A*.

bottom should be at least 6 inches below the lowest wood. The use of pressure-impregnated wood for such frames is desirable.

Skirting Between Foundation Piers

Where pier foundations are used it is often necessary to close the spaces between piers to make it easier to heat the buildings. If a skirting made of wood, fiber board, or other material containing cellulose is placed between the piers and in direct contact with the earth, it may be attacked by termites and may furnish them access to the wood above. Even though pressure-impregnated wood or asbestos board, metal, or other noncellulose material is used, very favorable conditions for hidden upward tubing by termites are provided by the

crevice between the piers and skirting. It is therefore necessary to maintain a minimum clearance of 2 inches between the lower edge of the skirting and the earth and 1 inch or preferably 2 inches between the sides of the skirting and the piers (fig. 22). Where such clearance is undesirable, provision should be made to hinge the skirting so that it can be removed or swung back and fastened during the active termite season.

Where hinging is impractical, and permanent, complete closing of the space between piers is required, a low concrete wall or beam should be poured integral with the piers. The skirting may then extend

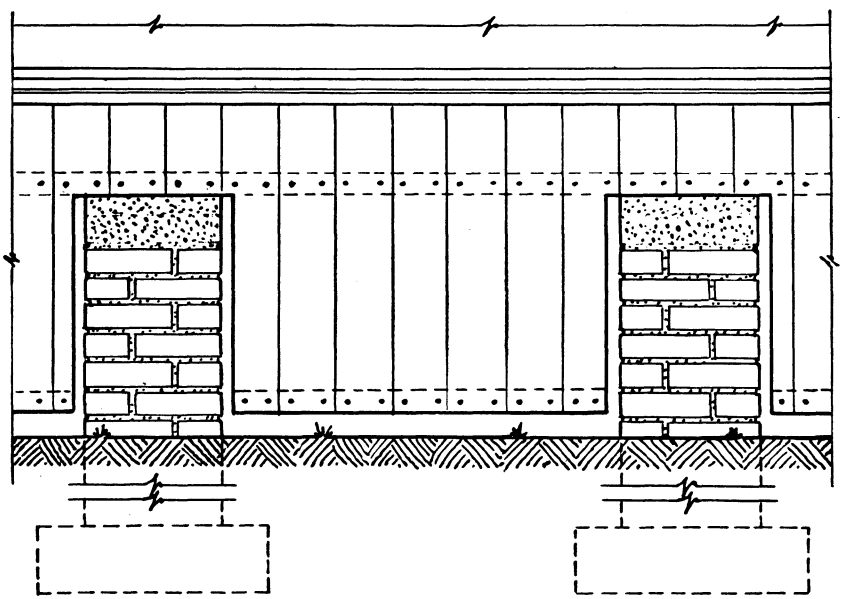


FIGURE 22.—Wooden skirting between piers with a minimum side clearance of 1 inch and ground clearance of 2 inches to prevent attack by termites and decay. Note concrete cap on brick pier to force termites into the open and prevent hidden infestation. Inspections will reveal tubes which can be destroyed, and the soil can be poisoned if necessary.

down to this wall and across the outside faces of the piers, but must be kept at least 6 inches above grade at all points. An access door must be provided to allow frequent inspections of the piers, wall, and skirting for the presence of termite tubes.

In the case of inexpensive structures, such as barracks, a practice often used in rural sections may be followed. It is simply the piling of dirt against the base of the skirting in the fall and removing it in the spring—thus protection for warmth is obtained during the winter and adequate ventilation in the summer.

Wood nailing strips or stakes that are in contact with or actually driven into the ground are often used as a means of fastening the sections of skirting between piers. This is a very undesirable practice, as it gives termites a direct wood connection between the soil and the building. It is usually possible to give adequate support and rigidity to the skirting by bracing from above and from the sides of the piers without using wood that is in contact with the ground.

WOOD USED IN BASEMENTS

Partitions and Bins

Wooden basement partitions, posts, and stair carriages should be placed after the concrete floor is poured and should never extend into or through the concrete (fig. 23). Metal clips may be used to anchor

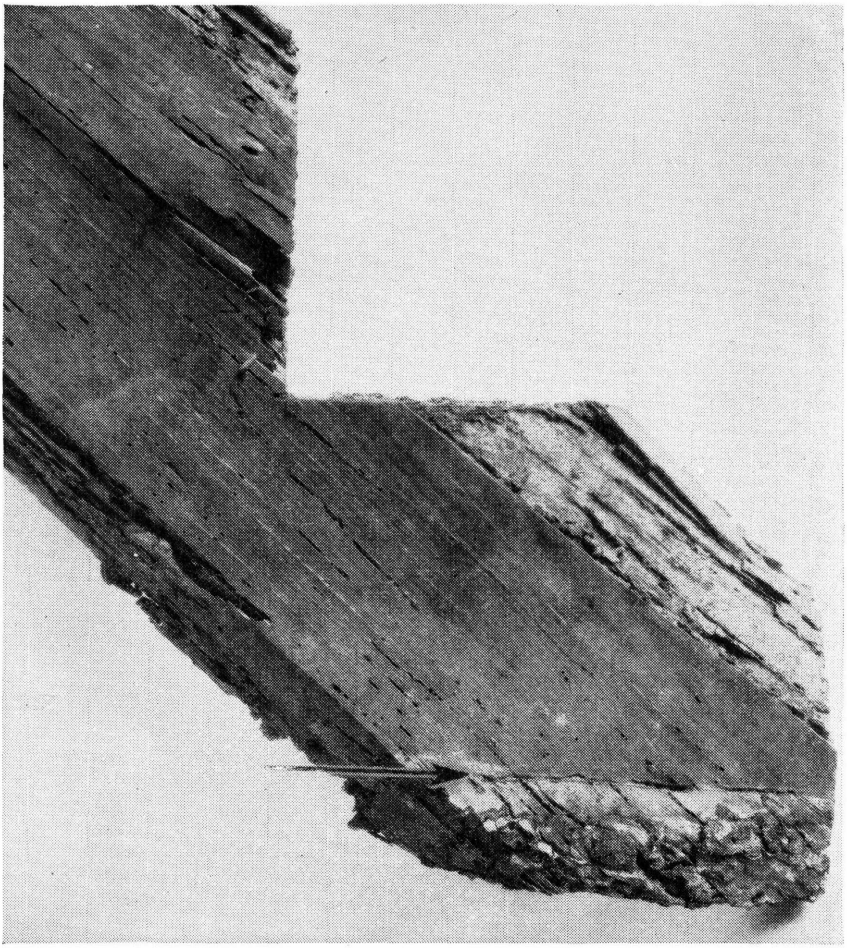


FIGURE 23.—Termite damage to stair carriage in basement, resulting from the member being put in place before the concrete floor was poured. Line across bottom of carriage (arrow) indicates floor level.

such members to the floor. Reinforced concrete should be used under supporting posts or partitions and under heating units, coal bins, or other points where heavy loads will occur. Metal plates, or concrete footings extending above the floor level, under wood posts, partitions, stair carriages, etc., may be used to prevent termites from gaining entrance to wood through cracks in the floor and also will aid in preventing decay.

A 1-inch layer of cement plaster should be applied to masonry foundation walls at the points where partitions abut such walls. This coating should be slightly wider than the thickness of the partition. It will serve to insulate the studding from the wall and will reduce the danger of termite invasion through cracks or crevices in the wall. A sheet of corrosion-resistant metal will be even more effective for this purpose.

Finished Basement Walls

Termite infestations in basement rooms with furred and finished wall surfaces below the outside grade level are very difficult to detect

FIGURE 24.—Termite damage to untreated sleepers embedded in concrete flooring.

and control. No fully effective method of preventing such infestations has been devised, but several measures can be suggested for reducing the hazard. Unit masonry walls are almost certain to have voids or cracks. Poured-concrete walls offer much better protection. The surface of either type of wall should be given a heavy mop or plaster-coat of coal-tar pitch or plastic cement before furring strips are put in place, as a means of reducing moisture penetration. The expansion joint between the concrete floor and the wall should be sealed with coal-tar pitch or a crimped metal connector and covered with a cement sanitary cove poured continuous with the surface of the floor.

If wood must be used as furring or for the finished surface, it should be pressure-impregnated with an approved preservative (see page 26). An alternative is to use metal furring and lath covered with plaster or other noncellulose material. Either of these measures will reduce the

danger that termites will enter through the foundation wall and be led upward between the wall and finished surface to reach untreated wood above.

Wood Floors Over Concrete

Experience has shown that untreated wood floors over concrete floors in basements are very likely to be infested by termites (fig. 24). Pressure-impregnated lumber should be used for sleepers or nailing

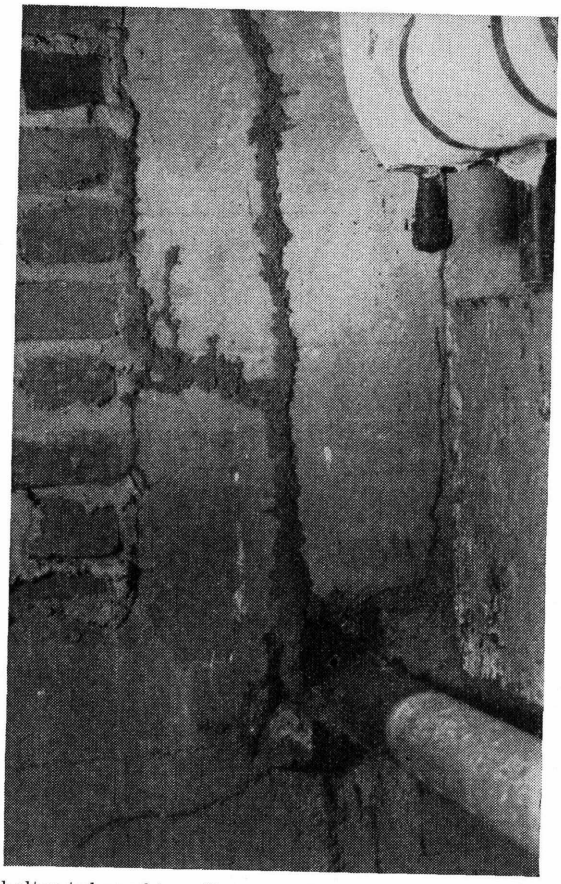


FIGURE 25.—Shelter tubes of termites extending upward from pipe to reach wood. The termites penetrated the space around this pipe.

strips and subflooring (see page 27). The sleepers should not be embedded in the concrete but may be fastened to it with metal clips. Expansion joints in the concrete floor and between the floor and wall should be sealed either with coal-tar pitch or crimped metal connectors. A cement sanitary cove poured continuous with the finish layer of the floor and extended up on the wall for an inch or two above the surface of the wood floor will give added protection. A thorough waterproofing coating, such as roofer's felt mopped on with asphalt, should be applied before the wood floor is laid. Every effort should be made to

prevent the formation of concealed cracks in the concrete which will provide hidden points of entry for termites.

Girders, Sills, or Joists Below Grade

Wooden girders, sills, or joists in or on foundation walls should not be placed below the outside grade level because termites may find hidden access to this wood. Decay will also be a serious problem under such conditions. Floor joists and girders set in masonry or concrete walls should have an air space of at least 1 inch around the sides and ends.

WATER PIPES AND CONDUITS

All plumbing, electric conduits, etc., should be clear of the ground and suspended from girders and joists. They should not be supported by wooden blocks, stakes, or partitions connecting with the ground, because of the danger of termites tunneling through or constructing tubes over such supports up to the joists, sills, and floors.

If metal termite shields are used on the foundation, a funnel type of shield calked with coal-tar pitch should be fastened tightly around all vertical piping, with a clearance of at least 12 inches, and preferably 18 inches, between the ground and the shields.

Where pipes or steel columns penetrate concrete ground slabs or foundation walls, the spaces around them should be filled with coal-tar pitch or coal-tar plastic cement, to prevent entry by termites (fig. 25).

CONCRETE PLATFORMS OR GROUND SLABS

Dwellings, warehouses, garages, storage depots, or similar structures having concrete floors on grade should have no untreated wood below the level of the upper surface of the floor. The top of the foundation wall should extend at least 6 inches above the surface of the floor. If the foundation is of unit masonry it should be capped with a minimum of 4 inches of reinforced concrete. Wood partitions should be placed after the floor slab has been poured, and no door frames, studs, or partition members should extend into or through the concrete floor. No wood plugs should be placed in these concrete floors for nailing. Cement floors should be properly reinforced at all points where they are likely to crack. When a wooden floor is to be laid over the cement floor or slab it should be protected as described on page 24.

A practice that is becoming common in low-cost housing is to pour a concrete ground slab continuous, or monolithic, with the foundation. If the slab is properly reinforced, there is little possibility of termite infestation in such a structure. In other instances the foundation is of unit masonry and the poured concrete slab is extended over the top of the wall (fig. 26). The outer edge of the slab should be flush with the outer face of the foundation, and the outside grade line must be kept at least 6 inches below the top of the slab and any wood siding or trim.

Another common practice, especially in the construction of brick-veneer buildings, is to extend the poured-concrete slab only part way across the top of the foundation, butting it against the brick veneer. This does not give as good protection because termites may succeed in penetrating through the horizontal joint between the foundation and slab and then upward through the crevice between the edge of the

slab and the brick veneer. One means of reducing this hazard is to apply a layer of coal-tar pitch or coal-tar plastic cement to the top of the foundation before the slab is poured, so as to seal this joint.

FIGURE 26.—Reinforced poured-concrete floor slab (arrow) extending over and to the outer surface of a masonry foundation, preventing hidden termite attack, even though a vertical crack has developed in the wall.

PRESSURE-IMPREGNATED AND NATURALLY RESISTANT WOODS

Treated wood has been mentioned under the discussions of skirting, foundation piers, flooring, sleepers on concrete slabs, and furring for walls. Its use is rather specialized but of value where protection from both decay and termites is needed or where wood must come in contact with the ground or be laid on concrete on the ground. For fence posts, poles, bridge timbers, etc., it is especially recommended. The heartwood of certain termite-resistant woods will give good but not equivalent service for such purposes. It should be clearly understood, however, that termites may construct tubes over the surface of either treated or naturally resistant wood to reach other wood in a building.

Treated Wood

The length of service to be expected from a given piece of chemically impregnated wood depends upon such factors as (1) the kind of preservative used, (2) the amount of preservative injected per cubic foot of wood, (3) the depth of penetration of the preservative, and (4) the conditions under which it is placed in service. The method of

treatment is important to the extent that it influences the absorption and penetration of preservative.

Pressure treatment in closed cylinders is the most reliable for satisfactory absorption and penetration, but, when skillfully employed with woods that treat readily, hot-and-cold bath treatment also gives good results. Brush, dip, or spray treatments usually give only very slight penetration and, consequently, only slight protection. Such superficial treatments usually do not add more than 2 to 5 years to the life of seasoned wood and are of little or no value where green material is used.

Timbers or lumber that must be used in contact with the ground should be thoroughly impregnated by a standard pressure process with either coal-tar creosote, creosote-coal-tar solution, or creosote-petroleum solution, with a retention of not less than 10 pounds per cubic foot of wood, to protect against damage by termites and decay.[3]

Lumber should be cut to finished length and all other cutting or framing should be done before treatment whenever possible, because cutting after treatment is likely to expose untreated surfaces. When cutting after treatment is unavoidable, the cut surfaces should be given two generous coats of hot coal-tar creosote or other suitable preservative.[4]

Naturally Resistant Wood

No wood is naturally entirely immune to attack by subterranean termites, but the heartwood of certain species of trees contains chemical extractives that are apparently repellent to them. This is particularly true for heartwood from trees that have made relatively slow growth. Sapwood is not resistant and should be removed from timbers that must be used in contact with the ground. Resistant woods that are available commercially include foundation grade California redwood (*Sequoia sempervirens*), all-heart southern tidewater red cypress (*Taxodium distichum*), and very pitchy or "lightwood" longleaf pine (*Pinus palustris*). Eastern redcedar (*Juniperus virginiana*) is fairly resistant and often available in quantities and sizes suitable for use as posts, poles, bridge timbers, or other purposes.

Resistant woods that may be available in tropical regions include teak (*Tectona grandis*) and sal (*Shorea robusta*) of India, cypress-pine (*Callitris robusta*) and camphor-tree (*Cinnamomum camphora*) of the Orient, and molave (*Vitex parviflora*) and ipil (*Intsia bijuga*) of the Philippines. Other tropical species may be known locally to be comparatively resistant to termites.

METAL TERMITE SHIELDS

Metal termite shields should be considered only as a supplement to good construction and not as a substitute for it. Where it is

[3] Under Federal Specifications TT–W–571b, the Department of Agriculture recommends impregnation under pressure with coal-tar creosote, creosote-coal-tar solution, or creosote-petroleum solution at the rate of 10 pounds per cubic foot for timbers to be used in contact with the ground; where timbers are to be used above ground and protected from weathering, it recommends impregnation under pressure with one of the following: Zinc chloride at the rate of 1 pound, chromated zinc chloride 0.75 pound, Celcure (acid cupric chromate mixture) 0.50 pound, zinc meta arsenite 0.35 pound, or Wolman salt (Tanalith) (fluoride-phenol-arsenic-chromium mixture) 0.35 pound, dry salt retention per cubic foot of wood.

[4] Nearly all preservative treatment of lumber is done by commercial firms having special equipment and workmen trained for the purpose. **Since all substances used for the preservation of wood against decay are more or less inflammable or poisonous, and coal-tar creosote mixtures will irritate the skin, special care is necessary in the use of these substances. Those applying coal-tar creosote as here recommended, or handling the treated lumber, should protect the skin of the face and hands by the use of some suitable cream or oil.**

desired to use every possible means of avoiding infestation by termites or where it is impossible to comply with the foregoing recommendations as to structural requirements, it may be desirable to use shields as an additional precaution. If used, they must be very carefully designed and installed, otherwise they will be ineffective. The installation of termite shields should never be regarded as an excuse for allowing or

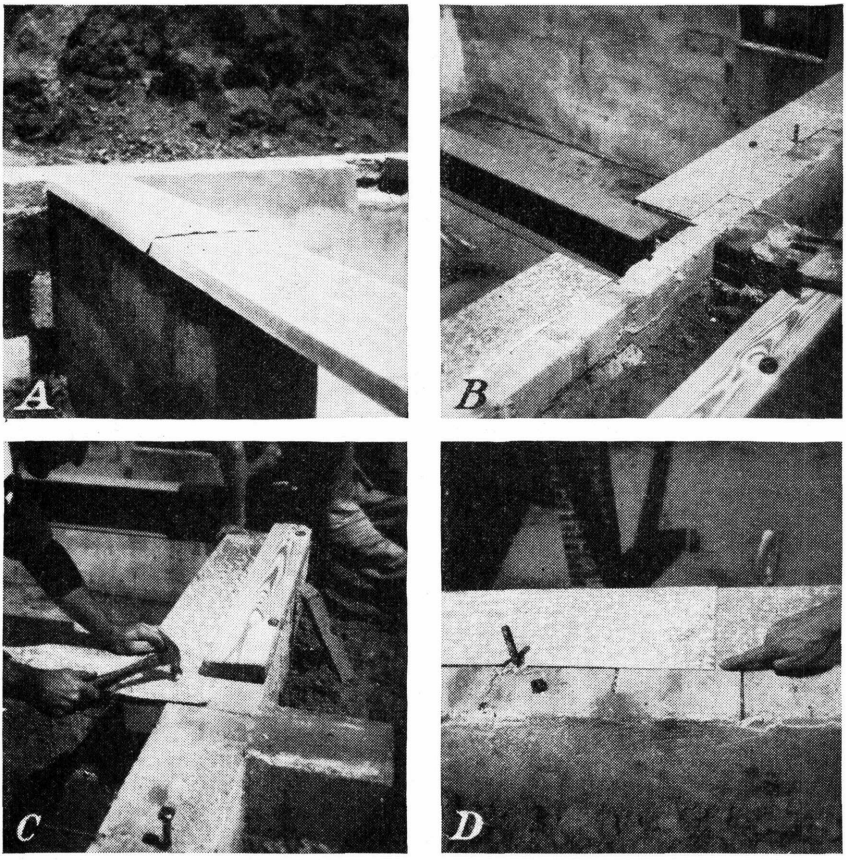


FIGURE 27.—Improper methods of shielding. *A*, Bread-pan or through shield with penetrable lapped, unsoldered joint; *B*, uncapped strip shield on top of wall, also unprotected steel I-beam; *C* and *D*, shield nailed to concrete, metal joints penetrable, sill unprotected from hidden attack through unfilled joints in masonry.

accepting construction practices that favor the development of a large population of termites in the soil beneath or adjacent to a building.

Recent experience has shown that the great majority of shields now in use have been poorly designed and incorrectly installed, giving the owner a false sense of security. The following are the mistakes most commonly observed where shields have been used (figs. 27, 28, and 29):

1. Loose joints between sections of metal, often with no evidence of any attempt to solder or otherwise make a tight joint.
2. Improperly cut and soldered corners or angles where walls intersect.

3. Strip shields placed on top of foundations instead of being embedded in or attached to the side of the wall.
4. Anchor-bolt holes cut in bread-pan shields and not sealed with coal-tar pitch.
5. Insufficient clearance between the outer edge of the shield and adjacent woodwork or piping.
6. Shields less than 12 inches above grade line, sometimes even buried by grading operations.
7. Projecting edge of shields battered and bent out of shape, often flattened against piers or foundation wall.

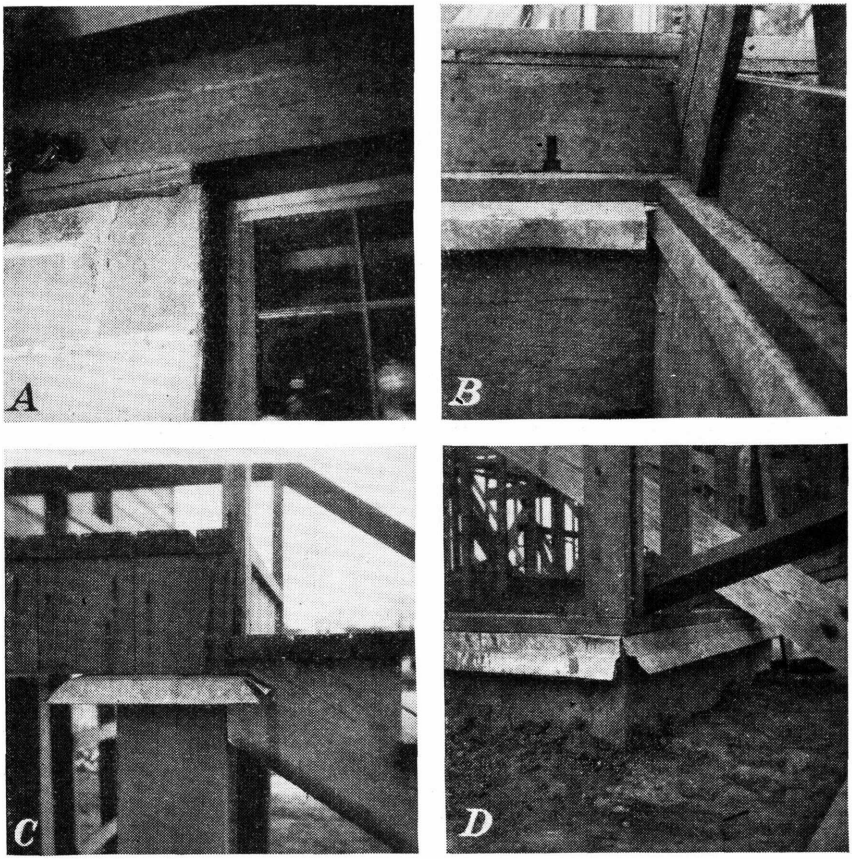


FIGURE 28.—Improper methods of shielding. *A*, Shield not continuous over window, permitting attack through frame to sill; *B*, joint left open at corner, permitting termite passage; *C*, poor soldering, which allowed joint to open in handling; lack of clearance from wood around edge of shield nullifies shield's effectiveness; *D*, open joint at corner.

8. Shields installed on sections of a foundation where there was little danger of termites attempting to gain entrance to the building, whereas the points of greatest danger, such as filled porches, were left unprotected.
9. Shields constructed of materials subject to rapid corrosion or to being easily torn or bent out of shape.

It should be remembered that shields, even when properly installed, will give protection only during the period that the metal lasts.

Recent laboratory experimental work with various types of termite shields has shown that no shield developed thus far is absolutely

effective in preventing the passage of termites. A properly made and installed shield will, however, force the termites into the open where they can be seen and will thus act as an effective barrier to hidden attack. Termites may construct tubes on the lower surface of a shield, and occasionally one of these tubes will be extended around the edge and up over the upper surface. Frequent inspection for the presence of such tubes, therefore, is essential. If termites do

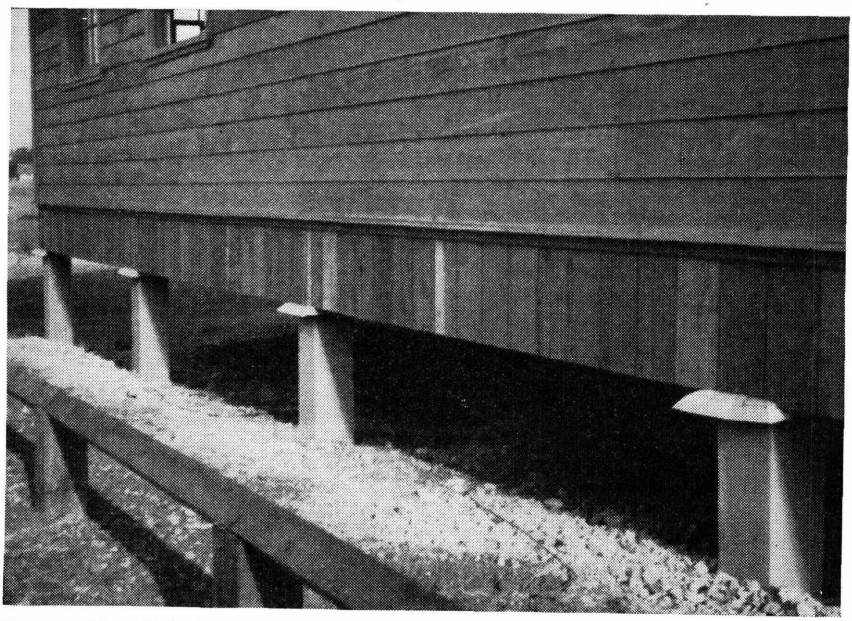


FIGURE 29.—Shields on poured-concrete piers. Such shields are unnecessary in this case, as adequate clearance has been provided to permit periodic inspections. Termite tubing is infrequent in such exposed places where ventilation is good.

succeed in getting past the shield, it may be necessary to apply a soil poison at the point where the colony is located.

The physical characteristics that appear to be requirements for an effective shield include at least the following:

1. The shield must be constructed of material that is impenetrable to termites. Copper or galvanized iron is most generally used.
2. The surface of the material must be smooth, i. e., slippery or polished, as any roughness makes it easier for termites to attach their tubes to it.
3. The outer edge of the shield should be as thin as possible. A smooth, thin edge makes it difficult for termites to extend their tubes from the lower to the upper surface of the shield and appears to be the most effective feature involved.
4. The projecting edge of the shield should be at least 2 inches from any other object and at least 12 inches above the ground. Termites will often extend their tubes out beyond the edge of the shield. If these free tubes come in contact with a wall, pipe, skirting, or other object that is connected with the structure above, the shield is rendered ineffective.

Several types of shields are available for use on foundations. The type best suited for any particular building will depend upon the nature of the foundation.

The Bread-pan Type of Shield

The bread-pan shield is especially suited for use over masonry walls or piers (stone, tile, brick, or hollow or solid blocks) that are not properly capped with 4 inches of reinforced poured concrete, to prevent termites from working through or between such units and reaching the structural timbers (fig. 30). The following describes their proper installation:

1. On interior walls and piers, extend the metal entirely across the top of the wall or pier and beyond it to project 3 to 4 inches on each side, with the outer portion bent downward at an angle so that the edge of the shield will have a clearance of at least 2 inches from any timber or other object.

2. On exterior foundation walls and piers the projection beyond the outer face of the wall may be reduced, as the wall surface is exposed and any termite activity can be readily detected. The same is true for the inner side of a wall around a full basement. However, the metal should extend far enough beyond the wall to allow a slight downward projection and to be readily inspected. If inspections are impossible or impractical, full projection should be provided, the same as for interior walls and piers.

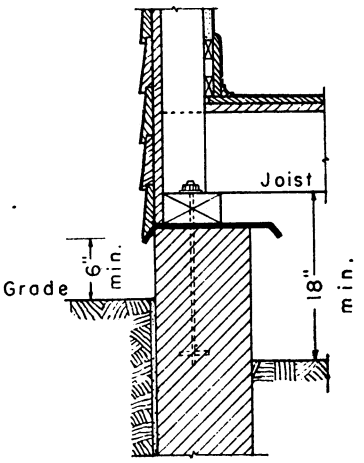


FIGURE 30.—Bread-pan or through shield over uncapped brick wall.

When the spaces between exterior piers are closed with skirting or lattice work a minimum clearance of 2 inches must be provided around the edge of the shield, 1 inch between the sides of the skirting and the piers, and 2 inches between the lower edge of the skirting and the ground.

In all bread-pan shielding work the shield should be bedded on fresh cement mortar, coal-tar pitch, or coal-tar plastic cement, to seal any openings around anchor bolts.

The Strip Type of Shield

The strip shield is embedded in, or attached to, the side of the wall in such a manner as to form an impervious and permanent joint or union between the metal and wall. It is particularly adaptable for use on poured-concrete walls but may be used on properly capped masonry foundations if attached to or embedded in the poured-concrete cap.

One type of such shield for use on a unit masonry wall consists of a sheet of metal 8 inches wide embedded near the top of the foundation wall (fig. 31). The wall should be built to within 4 inches of its ultimate height and then leveled with fresh mortar before the shield is put in place. The strip should extend over the wall for a distance of 4 inches and be properly anchored. Rust-proof nails should be driven through the shield about 1 inch from the inserted edge at every interval of 3 or 4 feet along the strip while the concrete is still "green." The wall must then be capped with 4 inches of reinforced concrete. This leaves exposed a projection of 4 inches, the outer half of which should project downward at an angle to clear all surfaces by at least 2 inches.

Other shields of this general type have been developed by private industry; many of them are patented. Most of them are firmly inserted or are attached by screws or nails to lead plugs embedded in impervious foundation walls, and with the joint between the wall and the shield sealed by means of dense concrete or coal-tar pitch. Those which are designed and installed so as to meet the entomological requirement of providing a permanently impervious barrier to termites should be effective.

General Requirements for Installing Shields

In addition to the requirements mentioned above under each type of metal barrier, the following apply:

Where the barrier is made of copper, "cornice temper" hardness should be specified and it should preferably be not lighter than 16 ounces to the square foot. Where other metals, such as copper-bearing or ordinary galvanized iron, are used, not less than 26-gage should be specified.

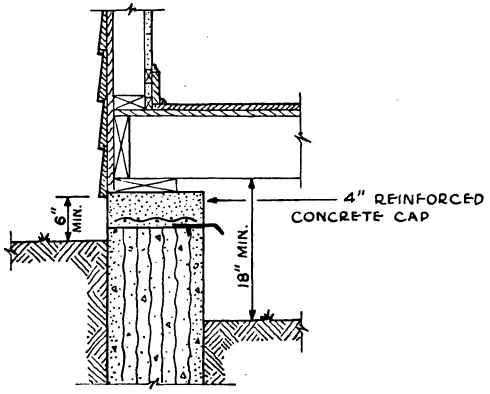


FIGURE 31.—Strip shield in masonry wall.

The joints between sections of the shield should be double-locked, riveted, and soldered, or otherwise fastened with termite-proof joints to take up expansion and contraction stresses.

All corners and intersections should be securely joined without gaps or uneven edges.

Painting the upper surface of galvanized-iron shields, using an aluminum or other suitable durable paint, will add to the life of the metal. Care should be taken not to allow an excess of paint to collect in beads along the edge of the shield, as any roughness may enable termites to extend their tubes around the edge and thus render the shields ineffective.

Steel I-beams or girders inserted in the wall below grade or below the shield line must be boxed or otherwise protected so that the continuity of the shield is not broken.

Where shielding levels change, as at differences in outside grade lines, a vertical section connecting the lower and higher levels should be installed.

PERIODIC INSPECTIONS

Periodic inspections for evidence of termite attack should be made of all buildings in sections of the country where termites are known to be a hazard. **This is simply a matter of good insurance and should be insisted upon regardless of how completely preventive measures have been employed in construction.** The frequency at which such inspections are needed will depend upon the abundance of termites in the area and the type of construction involved. In no instance should more than 12 months pass between inspections. If termite infestation is found, control measures as described in the following section should be employed to destroy the colony while it is still localized.

CONTROL OF TERMITE INFESTATIONS

When a termite infestation is discovered in a building, prompt steps should be taken to determine the seriousness of the situation and apply control measures. Further examination may reveal only a very localized infestation which can be controlled by employing sanitation methods, possibly supplemented by the application of a soil poison. If the infestation is found to be extensive and to involve serious structural damage, it may be advisable to secure the advice and services of some one who has had training and experience in the use of sound structural practices and in the application of termite-control measures.

The same principles should be observed in applying measures for the control of termite infestations in existing buildings as are recommended for the construction of new buildings. That is, existing conditions that are favorable for the development of termite colonies in the soil and that permit the passage of termites between the soil and the woodwork of the building should be corrected. Termites that are in the woodwork of a building will die if they are prevented from maintaining contact with the soil and moisture.

SANITATION AND STRUCTURAL CONTROL METHODS

Sanitation measures, such as removing all old form boards and other wood debris from the soil adjacent to the foundation or beneath the building, should be given first attention. If no wood is left in the soil, the termites cannot continue to exist unless they can maintain contact with woodwork in the building.

The next step should be aimed at blocking the termites from the building. The most effective and permanent means of accomplishing this objective is to make structural changes which will insulate all woodwork from the ground and allow proper ventilation of unexcavated areas enclosed by the foundation. All wood that has been structurally weakened should be replaced, and wood members that have been in contact with the soil should be removed and supported on poured concrete. Voids, cracks, or expansion joints in concrete or masonry under wood should be filled with cement grout, coal-tar pitch, or coal-tar plastic cement. Additional openings for ventilation may be needed in the foundation wall. Most of the structural details recommended in the preceding section on methods of preventing termite infestation in new construction will apply equally well in the reconstruction of infested existing buildings and should be consulted for additional suggestions.

Under certain conditions, especially where large colonies of termites are present and where it is difficult or impossible to make the foundation of the building impervious to termites, the most effective control measure may be the installation of metal shields between the foundation and the woodwork of the building. Only the most careful work will be effective, however, and careless installation will result in little or no protection, being a waste of time and money.

Before shields can be installed, it is often necessary to raise the building from its foundation, remove damaged timbers, and prepare the top of the foundation for receiving the shields. In other instances it may be possible to remove alternate short sections of the top of the wall and thus give room for inserting the shield without raising the building. After these places are shielded, the remaining sections must

be protected in a similar manner. The shield sections must be very carefully joined by riveting and soldering or by use of double-locked joints. Particular care must be taken at corners and where there are changes in level. Details concerning types of shields are given on pages 31 and 32.

CHEMICAL CONTROL METHODS

Soil Poisons, their Characteristics, and Precautions Necessary in Handling Them

Chemicals toxic to subterranean termites can be used advantageously to check infestations present in the soil. They are useful in treating new building sites where termites have become established, as well as in serving as a valuable adjunct to structural changes for checking infestations in buildings. Chemical treatments lack permanent value, however, and should not be considered as equivalent to proper structural methods. Moreover, satisfactory control in buildings cannot be expected where the chemicals are applied to or about wood that is left in contact with the ground.

An ideal type of chemical for such treatments would be one that is effective for a long period, safe to handle, cheap, odorless, and not injurious to humans, pets, and shrubbery. The period of protection depends upon several factors, such as the nature of the chemical, the manner of application, the texture and chemical nature of the soil, the level of the water table in the soil, the movement of subsurface drainage, and the exposure of the treated soil to the weather.

In normal times four of the more readily obtainable and effective chemicals for use in termite control are sodium arsenite, coal-tar creosote, pentachlorophenol, and orthodichlorobenzene. Preliminary tests have shown that, when properly applied, these chemicals may be expected to give protection for at least 5 years.

Sodium arsenite is an arsenical that is highly toxic to termites. It is odorless, relatively cheap, and can be purchased as a powder or as a concentrated solution. In light, sandy soils where there is heavy rainfall or where there is much subsurface drainage, more of the chemical must be used than is needed in protected sites, as it is highly soluble and likely to be removed through leaching. In most situations, particularly beneath buildings where the chemical is protected from weathering and is not subject to leaching, a dosage of 1 gallon of a 10-percent solution to 5 cubic feet of soil is sufficient. This chemical is suited for use in basementless areas where chemicals with strong odors are objectionable. **As sodium arsenite is readily soluble in water and extremely poisonous to man and animals, care should be taken not to use it near wells or springs which serve as a source of drinking water. General precautions that should be observed in handling and applying this and other soil poisons are discussed on page 35.**

Coal-tar creosote [5] will penetrate the ground more readily when diluted with light fuel oil in the proportions of 1 part of creosote to 3 parts of oil than when used alone. It is insoluble in water, is easily obtained, and is not difficult to apply. The characteristic odor is usually not objectionable indoors after a period of 2 or 3 weeks and out of doors after a few days. **Caution should be exercised in handling**

[5] American Wood Preservers' or Federal Specification Grade 1 Oil has proved to be toxic to termites and does not possess so strong an odor as do some of the less refined creosote oils.

the mixture, as it irritates the skin and eyes. The mixture should be applied at the rate of 1 gallon per 5 cubic feet of soil treated.

Orthodichlorobenzene is one of the best known of the chlorinated benzenes. It is noninflammable, insoluble in water, and an excellent penetrant. It has an odor resembling that of paradichlorobenzene, a chemical that is widely used as a repellent for clothes moths. **It should not be used near a well or other exposed source of drinking water because, once the chemical reaches it, the water will absorb the odor and may be rendered unfit for use for a long time.** When applying orthodichlorobenzene it is advisable to provide free circulation of air, since the vapor, when confined, acts as an anaesthetic and is irritating to membranes of the nose and eyes. **Actual contact of the chemical with sensitive tissues is not permanently harmful but may be extremely painful.**[6] **Hands should be protected with rubberized gloves.**

This chemical costs considerably more than creosote or sodium arsenite—a fact which will tend to limit its use to situations involving porous walls and heavy soils that are difficult to treat with the other materials. It can be used alone at the rate of 1 gallon per 12 cubic feet of soil, or in the proportion of 1 part of orthodichlorobenzene to 3 parts of light fuel oil applied at the rate of 1 gallon of the mixture per 5 cubic feet of soil. The mixture usually will give the better results because of the larger volume of liquid and more thorough penetration of the soil. Except for small jobs, where cost may not be so important, orthodichlorobenzene is best used in mixture with coal-tar creosote and light fuel oil, where the orthodichlorobenzene will act partly as a fumigant to give a quick kill of termites in the soil, while the coal-tar creosote will serve for a considerable period mainly as a repellent to reinfestation. The proportions should be 1 part of orthodichlorobenzene, 1 part of coal-tar creosote, and 6 parts of light fuel oil, applied at the rate of 1 gallon of the mixture per 5 cubic feet of soil.

Pentachlorophenol is a chlorinated phenol that is being used as a wood preservative and a soil poison for termite control. It does not possess an objectionable odor, and when applied as a 5-percent solution in a fuel-oil type of carrier it penetrates the ground readily and is toxic to termites.[7] **Since the chemical might irritate the skin, the hands should be protected as specified for handling orthodichlorobenzene.** It should be applied at the rate of 1 gallon of the 5-percent solution per 5 cubic feet of soil.

General precautions regarding use of soil poisons.—Where valuable shrubs and flowers are near the area to be treated (1 to 3 feet) and where it is not desirable to remove them temporarily, the plants may be protected from the above-mentioned toxic chemicals by lining the side of the trench next to the shrubbery with tar paper, paraffined canvas, or copper-coated kraft paper. The last mentioned is preferable where orthodichlorobenzene, creosote, or light petroleum oils are used, since these chemicals have a solvent action on tar products.

Soil poisons should not be applied immediately following a heavy rain when the earth is soaked with water. Under such conditions there is little opportunity for the chemicals to penetrate through the

[6] To treat the eyes, bathe them with boric acid; and to relieve a mild skin irritation, apply bicarbonate of soda.

[7] Most fuel oils dissolve from 5 to 6 percent of crystalline pentachlorophenol at ordinary room temperatures. In kerosene and light naphthas, however, it is soluble only to the extent of about 3 percent. If it becomes necessary to use kerosene as a carrier, from 5 to 10 percent of a more active solvent, such as pine oil, raw linseed oil, or acetone, should be added. Prepared 5-percent solutions are available on the market.

spaces in the soil. To be most effective they should be used when the ground is dry and warm.

Those chemicals that have strong odors should not be used where food is stored.

Because of fire hazard, great care should be taken to avoid open flames or electric sparks when applying inflammable soil poisons, such as mixtures containing fuel oil, in a confined, poorly ventilated space.

Care should be taken in handling soil poisons not to allow the chemicals to come in contact with the skin or eyes. Most of them have a caustic action and may cause severe burning or irritation. Opened packages or containers should be stored where children or pets cannot get to them.

Treating New Building Sites

Where buildings are to be constructed in wooded areas or on old building sites, all decaying logs, stumps, larger roots, old lumber, and other debris should be removed and burned. Careful examination should be made for evidence of termites, particularly when construction is to take place on an undisturbed site, i. e., where no excavation is to be made. If termites are found, the infested soil should be drenched with one of the chemicals or mixtures mentioned above.

Poisoning the Soil About Infested Buildings

Where treatment with chemicals is deemed necessary, it should be the aim to poison the soil to a sufficient depth about walls and piers, especially those of masonry construction, and about pipes, to cover all possible points of termite entry. The treated barrier should be from 8 to 12 inches wide.

For chemicals such as sodium arsenite and coal-tar creosote in particular, the trenching method is most effective because the poison must be mixed thoroughly with the earth in order to obtain adequate distribution.

For chemicals like orthodichlorobenzene, which have fumigating properties that enable them to permeate soils readily, it is possible to use a bar-hole method where trenching is impractical. This method has been tested only in light, sandy loam soils, and at present it is recommended only for such situations.

Treating Foundations.—The poison should be applied to the soil adjacent to a masonry foundation wall having a deep footing, as along a full basement, by first digging a trench the width of a shovel and to a depth of at least 30 inches. A portion of the chemical should be applied to the bottom of the trench and the balance of it at about 6-inch intervals as the earth is replaced, so as to provide an even distribution from bottom to top. If the chemical is applied next to a poured-concrete wall devoid of cracks, only a shallow trench is necessary to hold the chemical in place until it is absorbed. Likewise, when a poison is used around a foundation having a shallow footing, as under a basementless area, a trench only a few inches deep is sufficient. In no case should the trench extend below the top of the footing.

If the wall or pier is porous, it may have to be drilled and flooded with the toxic material to obtain an adequate treatment. In addition, it may be necessary to punch holes from the bottom of the trench to near the footing, at intervals of 12 to 18 inches, to reach termites working underneath and up through the wall.

TREATING PORCHES AND ENTRANCE GROUND SLABS.—To treat and maintain an enclosed unfilled porch, it is necessary to make an opening in the wall at each end so that the interior can be inspected, any form boards or other wood present can be removed, existing termite tubes can be destroyed, and the space can be ventilated. One of these openings should be made large enough to serve as an access door to permit future inspections. The soil poison is then applied in a trench along the foundation and the walls supporting the porch.

If a termite infestation is located in a dirt-filled porch or other similar area adjacent to the exterior foundation wall, a metal apron should be inserted between the enclosed area and the wall, as described on page 16. If such procedure is impractical, a poison can be applied to the soil in a trench adjacent to the foundation after openings have been made through the side walls and after debris and the filled earth have been removed down to the outside grade. In some types of construction, where the slab is not well attached to the main wall, it may be necessary to install a supporting wall or piers to prevent cracking of the concrete or masonry slab.

In the case of an entrance ground slab adjacent to a masonry foundation wall surrounding a basement, it is often more convenient to work from the basement than to excavate beneath the slab from outside. First, remove 2 to 3 linear feet of the foundation wall, parallel with and slightly below the lower inner edge of the slab. Through this opening the soil can be removed from along the wall to provide a tunnel for inspection and to permit application of the chemical. An access panel or door should be installed in the opening to provide for future inspection.

Where the foundation wall is of poured concrete, it is usually easier to apply the soil poison from the outside than to attempt to bore through from the basement. This would mean excavating a shallow trench along the foundation wall and beneath the slab, working from one or both sides of the slab, removing any debris present, and applying the chemical in this trench. As in the case of porches, it may also be necessary to install a supporting wall or piers to reinforce the slab above and prevent cracking.

There are instances where it is next to impossible to trench under a ground slab abutting a building. Such cases may require removing a strip of the slab along the foundation wall. After the wood debris is taken out and the soil is chemically treated, the slab can be repaired. In other situations, rather than trench under or cut away a strip of the slab, it may be desirable to bore holes through the slab, at intervals of about 18 inches, near the foundation wall, and pour the chemical through the holes. After the treating the holes can be plugged.

Chemical Treatment of Infested Wood

Many attempts have been made to apply chemicals to wood in place in buildings, with the object of controlling existing termite infestations and preventing future damage. No effective control by spraying or fumigation has proved to be possible. It is not considered practical to secure effective penetration by injecting chemicals under pressure through bored holes without boring so many holes that the strength of the timber is seriously weakened. Such methods of control are therefore not recommended.

U. S. GOVERNMENT PRINTING OFFICE: 1942

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